

CLAIMS (U.S.)

1. An apparatus for calculating immunity from a radiated electromagnetic field which segments an antenna and electronic apparatus into elements, calculates a mutual impedance among elements, and solves simultaneous equations under the moment method defining a relationship among the mutual impedance, a wave source and an electric current flowing through the electronic apparatus so as to simulate the electric current flowing through the electronic apparatus due to a radio wave radiated by an antenna, provided with:

a first calculating means for setting a representative frequency with respect to a carrier wave frequency, at least one upper sideband frequency and at least one lower sideband frequency and calculating the mutual impedance among elements at that representative frequency and

a second calculating means for solving simultaneous equations under the moment method having the mutual impedance calculated by the first calculation means for the carrier wave frequency, upper sideband frequency and lower sideband frequency to calculate the electric current flowing through the electronic apparatus due to a radio wave radiated by an antenna.

2. An apparatus for calculating immunity from a radiated electromagnetic field as set forth in claim 1, further provided with:

a decomposing means for applying one of LU decomposition and LDU decomposition on a matrix of the mutual impedance calculated by the first calculating means,

the second calculating means solving the simultaneous equations under the moment method using the matrix of mutual impedances decomposed by the decomposing means.

3. An apparatus for calculating immunity from a radiated electromagnetic field which segments an antenna

and electronic apparatus into elements, calculates a mutual impedance among elements, and solves simultaneous equations under the moment method defining a relationship among the mutual impedance, a wave source and an electric current flowing through the electronic apparatus so as to simulate the electric current flowing through the electronic apparatus due to a radio wave radiated by an antenna, provided with:

a first calculating means for setting a representative frequency with respect to a carrier wave frequency, at least one upper sideband frequency and at least one lower sideband frequency and calculating the mutual impedance among elements at that representative frequency,

a second calculating means for solving simultaneous equations under the moment method having the mutual impedance calculated by the first calculating means, while ignoring a wave source of the electronic apparatus, for one of the carrier wave frequency, upper sideband frequency and lower sideband frequency to calculate the electric current flowing through the electronic apparatus due to a radio wave radiated by an antenna, and

a third calculating means for calculating the electric currents, other than the electric current calculated by the second calculating means, flowing through the electronic apparatus due to a radio wave radiated by an antenna, by proportional operations, by using the electric current calculated by the second calculating means and a value of a wave source of the antenna.

4. An apparatus for calculating immunity from a radiated electromagnetic field which segments an antenna and electronic apparatus into elements, calculates a mutual impedance among elements, and solves simultaneous equations under the moment method defining a relationship among the mutual impedance, a wave source and an electric

current flowing through the electronic apparatus so as to simulate the electric current flowing through the electronic apparatus due to a radio wave radiated by an antenna, provided with:

5 a first calculating means for setting a representative frequency with respect to a carrier wave frequency, at least one upper sideband frequency and at least one lower sideband frequency and calculating the mutual impedance among elements at that representative frequency,

10 a second calculating means for solving simultaneous equations under the moment method having the mutual impedance calculated by the first calculating means for the one of the carrier wave frequency, upper sideband frequency and lower sideband frequency which overlaps a frequency, including a higher harmonic component, of a wave source of the electronic apparatus, to calculate the electric current flowing through the electronic apparatus due to a radio wave radiated by an antenna,

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20 a third calculating means for solving the simultaneous equations under the moment method having the mutual impedance calculated by the first calculating means for one of the frequencies not used in the calculation by the second calculating means to calculate the electric current, other than the electric current calculated by the second calculating means, flowing through the electronic apparatus due to a radio wave radiated by an antenna, and

25
30 a fourth calculating means for calculating the electric current, other than the electric currents calculated by the second and third calculating means, flowing through the electronic apparatus due to a radio wave radiated by an antenna, by a proportional operation, 35 by using the electric current calculated by the third calculating means and a value of a wave source of the antenna.

5. An apparatus for calculating immunity from a radiated electromagnetic field as set forth in claim 4, further provided with:

5 a decomposing means for applying one of LU decomposition and LDU decomposition on a matrix of the mutual impedance calculated by the first calculating means,

the second and third calculating means solving the simultaneous equations under the moment method using the matrix of mutual impedance decomposed by the decomposing means.

6. An apparatus for calculating immunity from a radiated electromagnetic field as set forth in claim 1, wherein said first calculating means sets a representative frequency from among said carrier wave frequency, upper sideband frequency and lower sideband frequency.

7. An apparatus for calculating immunity from a radiated electromagnetic field as set forth in claim 2, wherein said first calculating means sets a representative frequency from among said carrier wave frequency, upper sideband frequency and lower sideband frequency.

8. An apparatus for calculating immunity from a radiated electromagnetic field as set forth in claim 3, wherein said first calculating means sets a representative frequency from among said carrier wave frequency, upper sideband frequency and lower sideband frequency.

9. An apparatus for calculating immunity from a radiated electromagnetic field as set forth in claim 4, wherein said first calculating means sets a representative frequency from among said carrier wave frequency, upper sideband frequency and lower sideband frequency.

10. An apparatus for calculating immunity from a radiated electromagnetic field as set forth in claim 5,

wherein said first calculating means sets a
representative frequency from among said carrier wave
frequency, upper sideband frequency and lower sideband
frequency.

5 11. An apparatus for calculating immunity from a
radiated electromagnetic field as set forth in claim 1,
wherein when considering a dielectric, a mutual
admittance and mutual reaction among elements at the
representative frequency are calculated in addition to
10 the mutual impedance and processing is performed in
accordance with simultaneous equations under the moment
method, considering a dielectric, having the mutual
impedance, mutual admittance and mutual reaction.

15 12. An apparatus for calculating immunity from a
radiated electromagnetic field as set forth in claim 2,
wherein when considering a dielectric, a mutual
admittance and mutual reaction among elements at the
representative frequency are calculated in addition to
the mutual impedance and processing is performed in
20 accordance with simultaneous equations under the moment
method, considering a dielectric, having the mutual
impedance, mutual admittance and mutual reaction.

25 13. An apparatus for calculating immunity from a
radiated electromagnetic field as set forth in claim 3,
wherein when considering a dielectric, a mutual
admittance and mutual reaction among elements at the
representative frequency are calculated in addition to
the mutual impedance and processing is performed in
accordance with simultaneous equations under the moment
30 method, considering a dielectric, having the mutual
impedance, mutual admittance and mutual reaction.

35 14. An apparatus for calculating immunity from a
radiated electromagnetic field as set forth in claim 4,
wherein when considering a dielectric, a mutual
admittance and mutual reaction among elements at the
representative frequency are calculated in addition to
the mutual impedance and processing is performed in

accordance with simultaneous equations under the moment method, considering a dielectric, having the mutual impedance, mutual admittance and mutual reaction.

5 15. An apparatus for calculating immunity from a
radiated electromagnetic field as set forth in claim 5,
wherein when considering a dielectric, a mutual
admittance and mutual reaction among elements at the
representative frequency are calculated in addition to
10 the mutual impedance and processing is performed in
accordance with simultaneous equations under the moment
method, considering a dielectric, having the mutual
impedance, mutual admittance and mutual reaction.

15 16. An apparatus for calculating immunity from a
radiated electromagnetic field which simulates an
electric current flowing through an electronic apparatus
due to a radio wave radiated by an antenna, provided
with:

20 a managing means for managing antenna
information for realizing a prescribed intensity of an
electric field on the electronic apparatus,

an acquiring means for acquiring antenna
information used for the simulation from the managing
means when a request for simulation is issued, and

25 a calculating means for segmenting said
electronic apparatus and an antenna specified by the
antenna information acquired by the acquiring means into
elements, calculating a mutual impedance among elements,
and solving simultaneous equations under the moment
method defining a relationship among the mutual
30 impedance, a wave source and an electric current flowing
through the electronic apparatus so as to calculate the
electric current flowing through the electronic apparatus
due to a radio wave radiated by an antenna.

35 17. An apparatus for calculating immunity from a
radiated electromagnetic field as set forth in claim 16,
further provided with:

a setting means for setting a threshold

voltage for a position between specified conductor elements and

an alarm means for comparing a voltage generated at a specified position between conductor elements, derived by making the voltage generated across a resistor, virtually inserted between the conductors, one obtained if the resistor has an infinitely large resistance, and the threshold voltage set by the setting means and outputting information on whether said voltage exceeds said threshold voltage or not.

18. An apparatus for calculating immunity from a radiated electromagnetic field as set forth in claim 16, further provided with:

a first computing means for assuming a state where there is no electronic apparatus, segmenting the antenna to be registered in the managing means into elements, calculating the mutual impedance among these elements, and solving the simultaneous equations under the moment method defining the relationship among the calculated mutual impedance, wave source of the antenna, and an electric current flowing through the elements so as to calculate the electric currents flowing through these antenna elements,

a second computing means for calculating the intensity of the electric field which the electric current calculated by the first calculating means causes in the electronic apparatus at different locations of installation, and

an executing means for changing the distance between the antenna and electronic apparatus and the value of the wave source of the antenna to determine the specific distance and value of the wave source giving the prescribed intensity of electric field calculated by the second calculating means and registering the thus prescribed antenna information in the managing means.

19. An apparatus for calculating immunity from a radiated electromagnetic field as set forth in claim 17,

further provided with:

a first computing means for assuming a state where there is no electronic apparatus, segmenting the antenna to be registered in the managing means into elements, calculating the mutual impedance among these elements, and solving the simultaneous equations under the moment method defining the relationship among the calculated mutual impedance, wave source of the antenna, and an electric current flowing through the elements so as to calculate the electric currents flowing through these antenna elements,

a second computing means for calculating the intensity of the electric field which the electric current calculated by the first calculating means causes in the electronic apparatus at different locations of installation, and

an executing means for changing the distance between the antenna and electronic apparatus and the value of the wave source of the antenna to determine the specific distance and value of the wave source giving the prescribed intensity of electric field calculated by the second calculating means and registering the thus prescribed antenna information in the managing means.

20. An apparatus for calculating immunity from a radiated electromagnetic field as set forth in claim 18, wherein

said first calculating means solves simultaneous equations under the moment method for one frequency among a carrier wave frequency, upper sideband frequency and lower sideband frequency to calculate the electric current flowing through the antenna.

21. An apparatus for calculating immunity from a radiated electromagnetic field as set forth in claim 19, wherein

said first calculating means solves simultaneous equations under the moment method for one frequency among a carrier wave frequency, upper sideband

frequency and lower sideband frequency to calculate the electric current flowing through the antenna.

22. An apparatus for calculating immunity from a radiated electromagnetic field as set forth in claim 16, wherein when considering a dielectric, a mutual admittance and mutual reaction among elements at the representative frequency are calculated in addition to the mutual impedance and processing is performed in accordance with simultaneous equations under the moment method, considering a dielectric, having the mutual impedance, mutual admittance and mutual reaction.

23. An apparatus for calculating immunity from a radiated electromagnetic field as set forth in claim 17, wherein when considering a dielectric, a mutual admittance and mutual reaction among elements at the representative frequency are calculated in addition to the mutual impedance and processing is performed in accordance with simultaneous equations under the moment method, considering a dielectric, having the mutual impedance, mutual admittance and mutual reaction.

24. An apparatus for calculating immunity from a radiated electromagnetic field as set forth in claim 18, wherein when considering a dielectric, a mutual admittance and mutual reaction among elements at the representative frequency are calculated in addition to the mutual impedance and processing is performed in accordance with simultaneous equations under the moment method, considering a dielectric, having the mutual impedance, mutual admittance and mutual reaction.

25. An apparatus for calculating immunity from a radiated electromagnetic field as set forth in claim 19, wherein when considering a dielectric, a mutual admittance and mutual reaction among elements at the representative frequency are calculated in addition to the mutual impedance and processing is performed in accordance with simultaneous equations under the moment method, considering a dielectric, having the mutual

impedance, mutual admittance and mutual reaction.

26. An apparatus for calculating immunity from a radiated electromagnetic field as set forth in claim 20, wherein when considering a dielectric, a mutual admittance and mutual reaction among elements at the representative frequency are calculated in addition to the mutual impedance and processing is performed in accordance with simultaneous equations under the moment method, considering a dielectric, having the mutual impedance, mutual admittance and mutual reaction.

27. An apparatus for calculating immunity from a radiated electromagnetic field as set forth in claim 21, wherein when considering a dielectric, a mutual admittance and mutual reaction among elements at the representative frequency are calculated in addition to the mutual impedance and processing is performed in accordance with simultaneous equations under the moment method, considering a dielectric, having the mutual impedance, mutual admittance and mutual reaction.

28. A method for calculating immunity from a radiated electromagnetic field which segments an antenna and electronic apparatus into elements, calculates a mutual impedance among elements, and solves simultaneous equations under the moment method defining a relationship among the mutual impedance, a wave source and an electric current flowing through the elements so as to simulate the electric current flowing through the electronic apparatus due to a radio wave radiated by an antenna, including:

a first processing step of setting a representative frequency with respect to a carrier wave frequency, at least one upper sideband frequency and at least one lower sideband frequency and calculating the mutual impedance among elements at that representative frequency,

a second processing step of solving simultaneous equations under the moment method having the

mutual impedance calculated at the first processing step, while ignoring a wave source of the electronic apparatus, for one of the carrier wave frequency, upper sideband frequency and lower sideband frequency to calculate the electric current flowing through the electronic apparatus due to a radio wave radiated by an antenna, and

a third processing step of calculating the electric currents, other than the electric current calculated at the second processing step, flowing through the electronic apparatus due to a radio wave radiated by an antenna, by proportional operations, by using the electric current calculated at the second processing step and a value of a wave source of the antenna.

29. A program storage medium storing programs used for realization of an apparatus for calculating immunity from a radiated electromagnetic field which segments an antenna and electronic apparatus into elements, calculates a mutual impedance among elements, and solves simultaneous equations under the moment method defining a relationship among the mutual impedance, a wave source and an electric current flowing through the electronic apparatus so as to simulate the electric current flowing through the electronic apparatus due to a radio wave radiated by an antenna, storing a program for executing by a computer:

a first calculation processing of setting a representative frequency with respect to a carrier wave frequency, at least one upper sideband frequency and at least one lower sideband frequency and calculating the mutual impedance among elements at that representative frequency and

a second calculation processing of solving simultaneous equations under the moment method having the mutual impedance calculated at the first calculation processing for the carrier wave frequency, upper sideband frequency and lower sideband frequency to calculate the electric current flowing through the electronic apparatus

due to a radio wave radiated by an antenna.

30. A program storage medium storing programs used for realization of an apparatus for calculating immunity from a radiated electromagnetic field, which segments an antenna and electronic apparatus into elements, calculates a mutual impedance among elements, and solves simultaneous equations under the moment method defining a relationship among the mutual impedance, a wave source and an electric current flowing through the electronic apparatus so as to simulate the electric current flowing through the electronic apparatus due to a radio wave radiated by an antenna, storing a program for executing by a computer:

a first calculation processing of setting a representative frequency with respect to a carrier wave frequency, at least one upper sideband frequency and at least one lower sideband frequency and calculating the mutual impedance among elements at that representative frequency,

a second calculation processing of solving simultaneous equations under the moment method having the mutual impedance calculated at the first calculation processing, while ignoring a wave source of the electronic apparatus, for one of the carrier wave frequency, upper sideband frequency and lower sideband frequency to calculate the electric current flowing through the electronic apparatus due to the radio wave radiated by an antenna, and

a third calculation processing of calculating the electric currents, other than the electric current calculated at the second calculation processing, flowing through the electronic apparatus due to a radio wave radiated by an antenna, by proportional operations, by using the electric current calculated at the second calculation processing and a value of a wave source of the antenna.

31. A program storage medium storing programs used

for realization of an apparatus for calculating immunity
from a radiated electromagnetic field which segments an
antenna and electronic apparatus into elements,
calculates a mutual impedance among elements, and solves
5 simultaneous equations under the moment method defining a
relationship among the mutual impedance, a wave source,
and an electric current flowing through the electronic
apparatus so as to simulate the electric current flowing
through the electronic apparatus due to a radio wave
10 radiated by an antenna, storing a program for executing
by a computer:

a first calculation processing of setting
a representative frequency with respect to a carrier wave
frequency, at least one upper sideband frequency, and at
15 least one lower sideband frequency and calculating the
mutual impedance among elements at that representative
frequency,

a second calculation processing of solving
simultaneous equations under the moment method having the
20 mutual impedance calculated at the first calculation
processing for the one of the carrier wave frequency,
upper sideband frequency and lower sideband frequency
which overlaps a frequency, including a higher harmonic
component, of a wave source of the electronic apparatus,
25 to calculate the electric current flowing through the
electronic apparatus due to the radio wave radiated by an
antenna,

a third calculation processing of solving
the simultaneous equations under the moment method having
30 the mutual impedance calculated at the first calculation
processing for one of the frequencies not used at the
second calculation processing to calculate the electric
current, other than the electric current calculated at
the second calculation processing, flowing through the
35 electronic apparatus due to a radio wave radiated by an
antenna, and

a fourth calculation processing of

calculating the electric current, other than the electric currents calculated at the second and third calculation processings, flowing through the electronic apparatus due to a radio wave radiated by an antenna, by a proportional operation, by using the electric current calculated at the third calculation processing and a value of a wave source of the antenna.

32. A program storage medium storing a program used for realization of an apparatus for calculating immunity from a radiated electromagnetic field, storing a program for executing by a computer:

acquisition processing for accessing a managing means for managing antenna information for realizing a prescribed intensity of an electric field on the electronic apparatus to acquire antenna information from the managing means when a request for simulation is issued and

calculation processing for segmenting said electronic apparatus and an antenna specified by the antenna information, acquired by the acquisition processing, into elements, calculating a mutual impedance among elements, and solving simultaneous equations under the moment method defining a relationship among the mutual impedance, a wave source and an electric current flowing through the electronic apparatus so as to calculate the electric current flowing through the electronic apparatus due to a radio wave radiated by an antenna.

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